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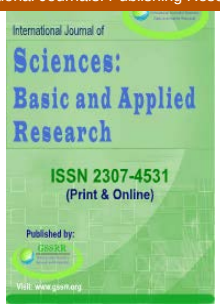

A Case Study Increasing Productivity with Barcode System Utilization Approach, Designing Supporting Tools and Lighting for Re-inspection Process in Manufacturing Company

Tulus Puji Ruswanto[a*], Hernadewita[b], Suhendris[c], Mohammad Rofiudin[d]

[a,b,c,d]*Faculty of Postgraduate, Magister of Industrial Engineering, Universitas Mercu Buana, Jalan Meruya Selatan No.1, Joglo, Kembangan, RT.4/RW.1, Meruya Selatan, Jakarta Barat, 11650*

Email: 55316120017@student.mercubuana.ac.id;

[a]*Email: tuluspujiruswanto78@gmail.com*

[b]*Email: hernadewita@mercubuana.ac.id*

[b]*Email: hadeita@yahoo.com*

[c]*Email: suhendris@yahoo.com*

[d]*Email: rofipiko@gmail.com*

Abstract

Quality Assurance is important thing in the company as a way to fullfill customer requirement where the final objective is company business sustainability. Because of that reason, the Re-inspection process that it is a part of quality assurance way that be implemented in manufacturing company, must support to provide the quality data record that should be faster and accurately and also have a validity data to measure the Performance of Inspection. It process also must optimize the all resources being used. The study be done in the manufacture company to anaylze the way to improve the reinspection process to make it high productivity and high quality product that be delivered to customer. The paper explain and deal that the QA Re-inspection process that be completed with supporting device, proper lumen lamp for lighting which is comply with lumen standard for inspection process, automatically entry data processing with use barcode system will give impact to increasing productivity performance of the Re-Inspection process. Supporting device be designed with utilize Auto Cad 2D and 3D software.

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* Corresponding author.

The design of supporting device be combined with determine dimension of the product and height of the lighting lamp as necessary needed by the inspection process. Anthopometry study of the inspector is other aspects for consideration the design. The design recording data reinspection product to the barcode system use python programming interfacing with mini computer Raspberry pi3 , which is it will replace the manual record processing. The study produce that the supporting device can be used for product range rim 20 in – 22.5 in. Study result also can show that with the lamp Philips type TL – 5 21 watt and the luminous (lm) 1950 need minimum 4 lamp which the height set of the lamp from the floor maksimum was 240 cm and refers to comparation against standard lighting for inspection process, it can be fullfilled by the design. Python programming for recording barcode scan with interface minicomputer Raspberry pi3 can record the data then the manual data record activity can be eliminated, the productivity increasing. Study showed with the recording data result of check in Re-inspection process with barcode system it can reduce 1 personnel that the job especially for entry data.

Keywords: Auto Cad 2D and 3D; Barcode; Raspberry Pi3; Re-inspection; Anthropometry; Productivity.

1. Introduction

Business sustainability is the objective all of the company in the world. Each company which are operate in manufacturing product and or service have effort to achieve that goal, take action and determine the management tool each company can be defined by own with consider their company condition. As we are know competition in the information age need each company to be able to mobilize and exploit its intangible assets (1). Different way with industrialization age that company more investing and managing physical and tangible assets [1] to make company success to win the competition. Positive Global reputation and sustanable bussiness performance will be attain if company focus on the relentless pursuit of quality [2] As prediction the global tire market is projected to reach 2.5 billion units by 2022 [3]. Keep and improving quality performance product that be delivered to the customer is important part of quality assurance. The approches for this point some study already done that increasing the amount of inspection activities and inspecting a large fraction of the items can improve quality that be delivered to customer [4]. The company that manufacture for tire product implement the process to measure the performance of inspection process with the name commonly use in internally company as QA Re-inspection process. Sample be taken from product that already inspected 100% by first visual inspection for the data attribute appearance tire before it go to the inventory warehouse. In fact this activity will give impact to the COPQ (Cost of Poor Quality) as mentioned by [5], the industry expenses average is around 20% to tied strictly their expenses for COPQ. With lesson learn of history performance feedback market and the Sigma level process capability, the decision to implement it still suitable, the important thing is the way to do it, more effective and efficient.

Concern with this, the QA Re-inspection process must be thinked for how it can be done properly comply with the related requirement, the accurately and validity be taken for sample in real time, not delaying product go to inventory since the process occured before it goes to warehouse inventory.

The study provide the analysis data for how to design the supporting device that be needed for the QA Re-inspection process if the available product range is Truck and Bus Radial tire with rim dimension 20 inch - 22.5 inch, how to determine and calculate the amount of lamp that be needed for support lighting the process and can fullfill standard refers to

Indonesia labour ministry regulation and [6], how to define the easy way automatically record and in real time can be accessed from PC computer stand alone or Web Service connected with Internet and also from the smartphone.

2. Methods

2.1. Anthropometry

Anthropometry is an empirical science that takes note and concerns with the physical measurements of the human body, such as the height, range of combined displacement and weight [8]. The anthropometric factors which should be taken into account, in the design of any product or environment, fall into four main areas: clearance, reach, posture and strengh. [9] . The application of this anthropometry will be possible if there is a mean (standard) and standard deviation of a normal distribution. The normal distribution is marked by the average value and standard deviation (standard deviation). While a percentile is a value that states that a certain percentage of a group of people whose dimensions are equal to or lower than that value. Normal distribution and percentil calculation, data source [7].

Table 1: Percentile and Average Standard deviation calculation

Percentile	*Calculation*
1 st	X - 2,323 σ
2,5 th	X - 1,960 σ
5 th	X - 1,645 σ
10 th	X - 1,280 σ
50 th	X
90 th	X + 1,280 σ
95 th	X + 1,645 σ
97,5 th	X + 1,960 σ
99 th	X + 2,323 σ

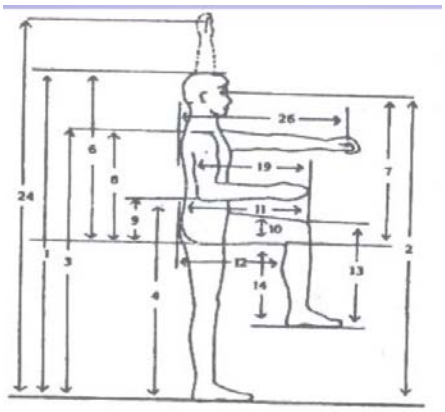

Figure 1 : Anthropometry part of the Human Body [7,8]

3.2. Number of Luminaires Calculation

In accordance with IESNA Lighting Handbook 9th edition, [9] the average illuminance calculation on indoor workspace (Average Illuminance Calculation), using Lumen Method as follows:

$$E = \frac{Tfw}{wa} \quad \text{.....(1)}$$

Where :

E = average of illuminance.

Tfw = Total flux onto workplace.

wa = workplane area.

When design targets are usually illuminated illuminances, a light loss factor must be applied to allow depreciation to be estimated in lamp lumens time after time. Estimated loss from gross clusters on luminaire surfaces (including lamps) and other factors affecting luminaire lumen output time after time. The formula is as follows [9]:

$$\text{E maintained} = \frac{(\text{Total lamp lumens}) \times \text{CU} \times \text{LLF}}{\text{wa}} \quad \text{.....(2)}$$

Where :

E maintained = Average of keeped illuminance.

CU = coefficient of utilization.

LLF = light loss factor.

wa = workplane area.

The lumen of the lamps in the formulation is more convincingly taken as a lumen of lamps averaged in luminaires. The formula is as follows [9]:

$$E_{maintained} = \frac{(n) \times (lpl) \times (ll) CU \times LLF}{wa} \quad \text{.....(3)}$$

Where :

$E_{maintained}$ = Average of keeped illuminance.

n = Number of Luminaires.

lpl = lamps per luminaire.

ll = lamp lumens.

CU = coefficient of utilization.

LLF = light loss factor.

wa = workplane area.

If desirable illuminance is desired, the above formula can be used to determine the total amount of desired luminaires.

$$n = \frac{(Emaintained) \times (wa)}{(lpl) \times (ll) XCU \times LLF} \quad \text{.....(4)}$$

3.2. Zonal Cavity Method

In accordance with the 9th edition of IESNA Lighting Handbook,[9] the following figure provides a procedure for calculating the average illuminance maintained using the Zonal Cavity Method.

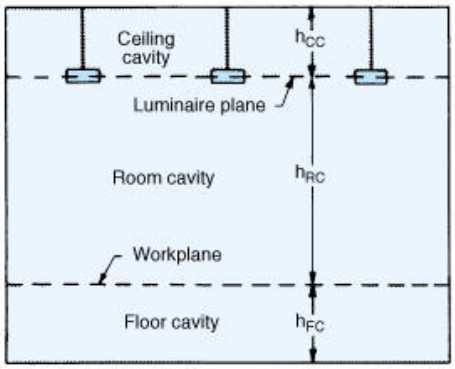

Figure 2: Cavities that be used for zonal-cavity method.Source : [9]

In Zonal-Cavity Method, the effect of room proportional, luminaire suspension length and work surface height on the utilization coefficient is adhered to by the cavity ratio, ceiling cavity ratio and floor cavity ratio. This ratio or comparison is determined by the space divided into three cavities as illustrated in Figure 2.1 above. By substituting the dimension then the formula can be determined as follows [9]:

$$CR = \frac{5\ h\ (cl + cw)}{cl \times cw} \quad \text{.....(5)}$$

Dimana :

CR : *Cavity ratio.*

cl : *Cavity length.*

cw *: Cavity width.*

h :

h = h_{RC} for the room cavity ratio (RCR).

h_{CC} for the ceiling cavity ratio (CCR).

h_{FC} for the floor cavity ratio (FCR).

Illuminance in an irregularly shaped room can be determined by room cavity ratio calculations using the following formula:

$$CR = \frac{2.5 \times (ch) \times (cp)}{Ab} \quad \text{.....(6)}$$

Where:

CR : *Cavity ratio.*

ch : Cavity height.

cp : Cavity perimeter.

Ab : area of cavity base.

3.4. Raspberry Pi 3 Type B

Minicomputer Raspberry Pi 3 Type B as below picture [15,]be used for interfacing recording data from barcode scanning process to MySQL database.

Figure 3: Raspberry Pi 3 Type B

(Source : www.raspberrypi-spy.co.uk)

Coding for installation programming in Raspberry Pi3 [10,20,24,25,26,31] can be shown as below figure

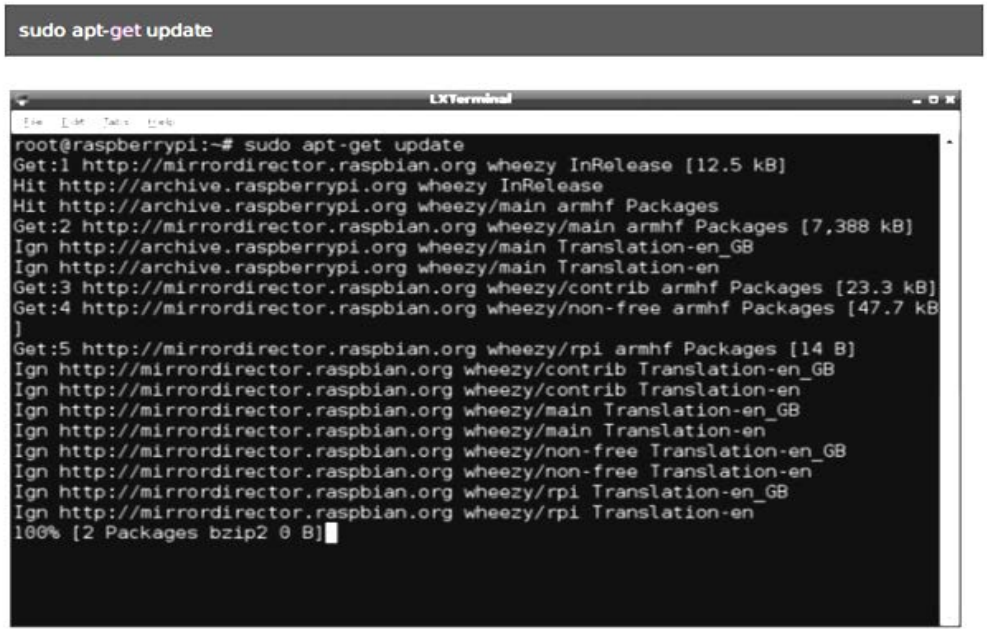

Figure 4: Adafruit Pi Code *(Source : www.cdn-learn.adafruit.com)*

Command promt that be used in installation process as below :

sudo apt-get install git

after git already istalled (if not yet exist in the raspberry) use " check out" Adafruit Pi Python repositori into Raspberry Pi3 with the command prompt:

git clone http://github.com/adafruit/Adafruit-Raspberry-Pi-Python-Code.git

cd Adafruit-Raspberry-Pi-Python-Code

ls

Python Language programming for MySql Database in real time [22,26,27,28,29] access to the web service with PhPmyAdmin.

The step by step in detail as follow :

a) Install mysql connector Python in Raspberry.

script that need to be installed to terminal raspberry pi.

```
pip install --allow-external mysql-connector-python mysql-connector-python
```

b) Install MySQL.

With use the command line in terminal Raspberry the install process MySQL as follow :

sudo apt-get install mysql-server

c) Install the PHP.

When MySQL already installed to the Raspberry, then after that need in later on the use PHP programming that be integrated with Python and MySQL. For it then need also to installed PHP in the Raspberry. Install process in the command line terminal be printed as follow :

sudo apt-get install mysql-client php5-mysql python-mysqldb

d) Install thew phpMyAdmin.

Write the command programme in the command line Raspberry terminal as below:

sudo apt-get install phpmyadmin

e) Setting Apache web server that needed to access the phpMyAdmin.

The configuration of Apache web server for access the phpMyAdmin be written in the command line Raspberry terminal as folow :

sudo nano /etc/apache2/apache2.conf

Then go to row file on the bottom row with push control –v many times.

Write in the command line on bottom row

Include /etc/phpmyadmin/apache.conf

Save the file and restart Apache2 ith write in the command line as follow :

sudo service apache2 restart

f) Looking for IP address in Raspberry Pi.

At the time desired that Raspberry as a web server can be accessed by other computers as a client then required the IP address of Raspberry connected with Wifi. To find the IP address of Raspbery then need to type the command in the command line in the terminal raspberry as follows:

sudo ifconfig.

When the experiment wifi tethering using wifi Advan X7 mobile phone obtained inet address 192.168.43.93 as the below figure :

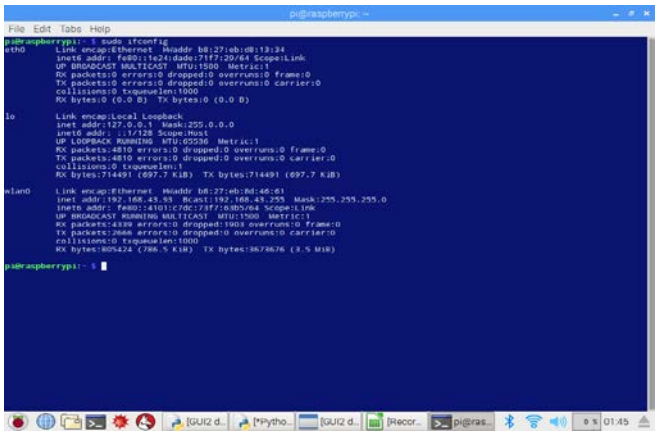

Figure 5: IP address Raspberry Pi3.

(Source : Own courtesy from experiment)

4. Methodology

The process flow for the methodoloy can be ilustrated as below Figure 6.

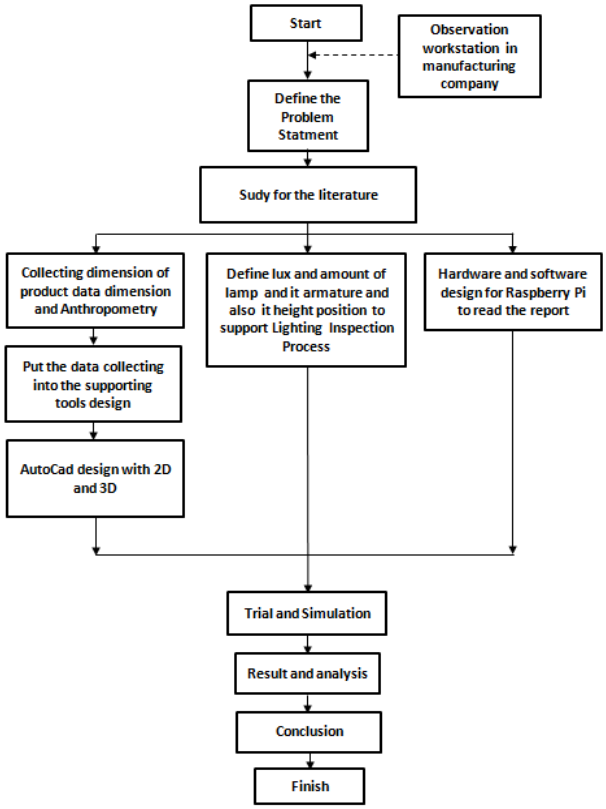

Figure 6: Flow process of methodology

4.1. Collecting of Necessary data

For the purposes of the study it requires direct observation to the process location to obtain the primary data. Data that be needed as follow :

a. Dimension data of the product

b. Data related to the anthropometry of inspectors

c. Flow process checking and how to manually record data of current conditions

4.2. Define the flow diagram of system

A study of python programming and GUI design (Graph User Interface) [17, 23] is used to obtain a barcode data recording program. As for in this research need to be made also data flow diagram like as follows

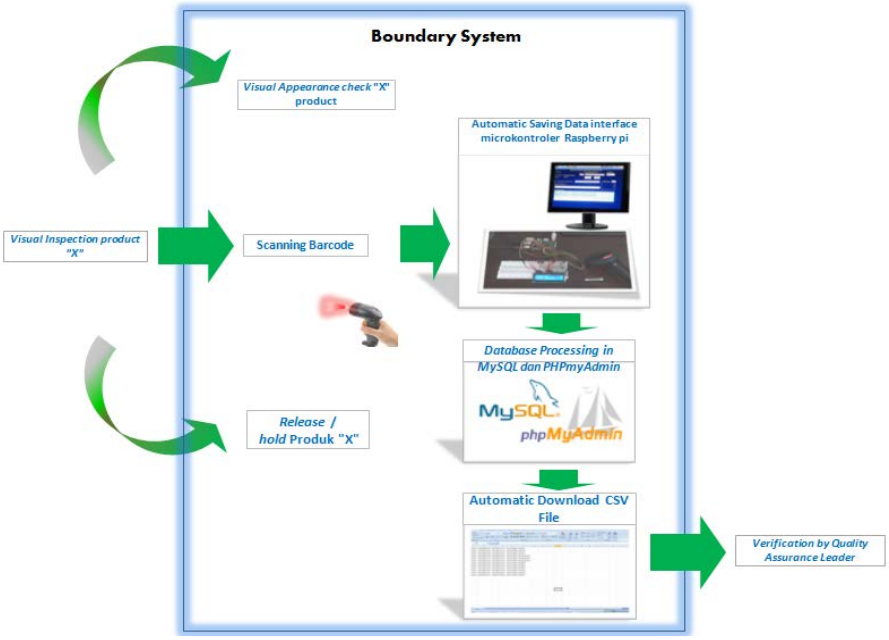

Figure 7: Boundary System

4.2. DataprocessingandTesting

Observation data that have been collected and then processed and then taken into account in the design. Utilization of AutoCad software 2D [11] and 3D [12,13] for designing drawing of work aids . All observations and designs of both software and hardware are processed and simulated

5. Result and Discussion

5.1. Design of Supporting device QA Re-Inspection Process

The product dimension reference provide as below :

Tabel 2 : Dimension of product

No	**Product Size**	***Design Rim Width*** **(inch)**	***Rim Size Diameter***		**Desain Produk Baru**		***Overall Diameter***	
			(inch)	**(mm)**	***Section Width (Inch)***	***Section Width (mm)***	***in***	***mm***
1	10.00 R20 16PR 146/143K	7	20	508	10.95	278	41.48	1054
2	11.00 R20 16PR 149/145K	8	20	508	11.55	293	42.7	1085
3	10.00 R20 16PR 154/149K	7	20	508	10.95	278	41.48	1054
4	11.00 R20 16PR 150/147K	8	20	508	11.55	293	42.7	1085
5	10.00 R20 18PR 149/146K	7	20	508	10.95	278	41.48	1054
6	10.00 R20 18PR 149/146K	7	20	508	10.95	278	41.48	1054
7	10.00 R20 18PR	7	20	508	10.95	278	41.48	1054
8	11.00 R20 18PR 152/149F	8	20	508	11.55	293	42.7	1085
9	12.00 R20 20PR 156/153F	8.5	20	508	12.4	315	44.28	1125
10	9.00R20 16PR 144/142K	7	20	508	10.2	259	40.1	1019
11	11.00 R20 18PR 152/149K	8	20	508	11.55	293	42.7	1085
12	12.00 R20 20PR 156/153K	8.5	20	508	12.4	315	44.28	1125
13	11.00 R20 18PR 152/149K	8	20	508	11.55	293	42.7	1085
14	12.00 R20 20PR 156/153K	8.5	20	508	12.4	315	44.28	1125
15	10.00R20 16PR 146/143K	7	20	508	10.95	278	41.48	1054
16	11 R22.5 16PR 148/145M	8.25	22.5	571.5	11	279	41.48	1054
17	295/80 R22.5 16PR 152/148M	9	22.5	571.5	11.73	298	41.1	1044
18	11 R22.5 16PR 148/145L	8.25	22.5	571.5	11	279	41.48	1054

With use 2D [11,12] and 3D [13] Auto Cad software the final result of design can be obtained as below figure 8

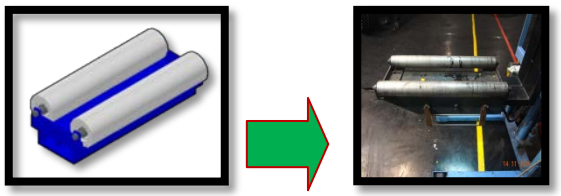

Figure 8: Design Result of Supporting Tools for QA-Reinspection Process.

5.2. Calculation result of Anthopometry Inspector who as participant in the process and the height of workpiece

Tabel 3: Anthropometry Data of QA Inspector

No	Body Dimention	Muhammad Budiyanto NIP : 13-0874	Bachtiar Dery NIP : 13-0061	Ahmad Rifai NIP : 13-0877	Hediyansyah NIP : 13-0063
1	Body Height (1)	167	165	165	167
2	Height of Angle Hand (4)	104	104	104	104
3	Length of angle that be measured from the angle into end (19)	43	43	43	43
4	The distance of hand reach that be measured from shoulder into the end of finger in the vertikal stright 90 degrees (26)	68	67	67	67
5	Age	26	23	25	26
6	The experience of work	3	3	3	3

5.3. Calculation and Analysis Result for Height of workpiece , height of lamp , total amount of lamp for lighting that be used in QA Re-inspection process

With the consider of anthropometry data the height of the workpiece from floor can be calculated . The logical reference be ilustrated as below figure .

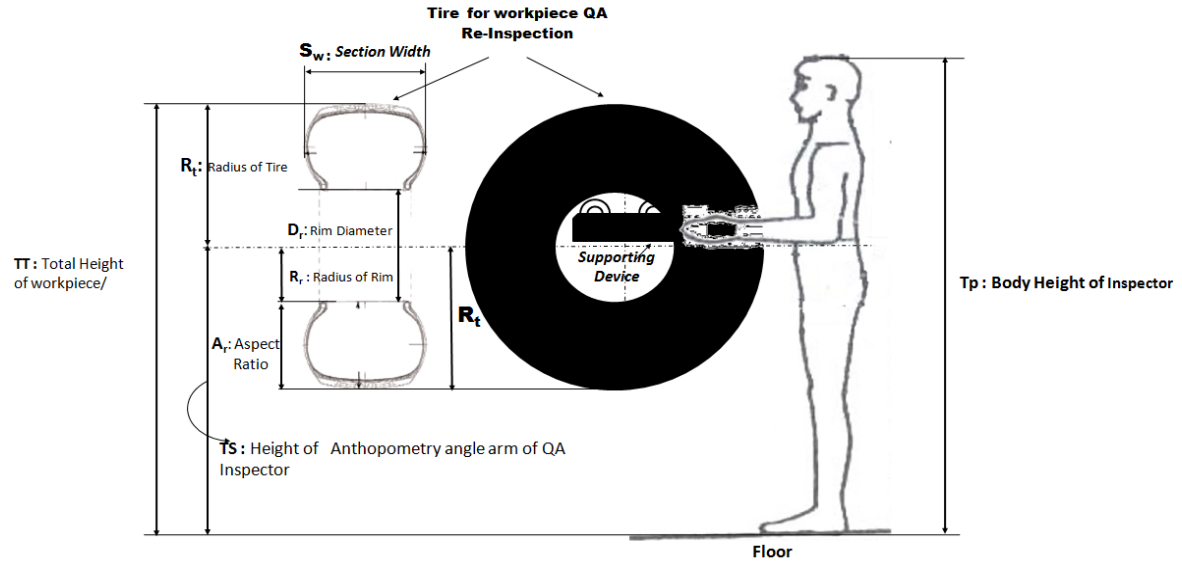

Figure 9: Logical reference to define the height of workpiece

Explanation of the figure :

- $\mathbf{S_w}$ is *section width* of tire the total width of tire.
- $\mathbf{A_r}$ is section height of the product.

If the aspect ratio is $\frac{Height\ of\ total\ surface\ of\ the\ tire\ \ (Ar)}{Total\ section\ width\ (\mathrm{Sw})}$……..(7)

Then the section height ($\mathbf{A_r}$) = *aspect ratio* x Section width of tire ($\mathbf{S_w}$) (8)

- $\mathbf{D_r}$ is the rim diameter be designed for product.
- $\mathbf{R_r}$ is radius of the rim that be used for tire assy.
- $\mathbf{R_{d=}}\ \frac{Dr}{2}$ …..(9)
- $\mathbf{R_t}$ is the radius of tire.

$\mathbf{R_t}$ can be calculated as below :

$\mathbf{R_t = R_d + A_r}$ with using the formula 9 dan 7

$\mathbf{R_t = (\ D_r / 2\ ) + (\ \textit{aspect ratio}\ x\ S_w\ )}$ …….(10)

- $\mathbf{T_p}$ is the height Anthropometry of Re-inspection Inspector.
- $\mathbf{T_s}$ is the angle height of Anthropometry *Re-inspection* inspector.
- **TT** is height of workpiece that be laying on the supporting device

Calculation of TT as below :

$\mathbf{TT_{average} = T_{s\ average} + R_{t\ average}}$ ……..….(11)

With the subtitution we can get the formula as below :

$\mathbf{TT_{average}} = \mathbf{T_{s\ average}} + \{(\boldsymbol{Dr}/2) + (aspect\ ratio\ X\ Sw)\}$ ……(12)

Anthropometry data for angle position in vertical position of the inspector as follow

Table 4: Anthropometry Reinspection Inspector.

Anthropometry	Inspector 1	Inspector 2	Inspector 3	Inspector 4	Mean	SD
Height of angle in vertical position	104 (cm)	104 (cm)	104 (cm)	104 (cm)	104 (cm)	0

During calculation it be taken that 1 percentil as reference , it have means that the population that have size less than sample can use without exceed the height angle 90 degree anthropometry , Ts be calculated with 1 percentil :

Ts = X – 2.323 σ coeficien variation 3.7 %

Ts = 104 – (2.323 x 0 x 0.037) = 104 cm.

5.4. Calculation average rate of workpiece from floor and height of the lamp from floor

With known the radius of tire as (Rt) that be assied with rim then the height of workpiece from floor can be calculated as below :

$$\mathbf{TT_{average} = T_{s\ average} + R_{t\ average}} \ldots\ldots(13)$$

$\mathbf{TT_{average} = 104\ cm + 53.5\ cm}$

$\mathbf{TT_{average} = 157.5\ cm}$

From calculation can get value of $\mathbf{TT_{average}}$ the value is 157.5 cm

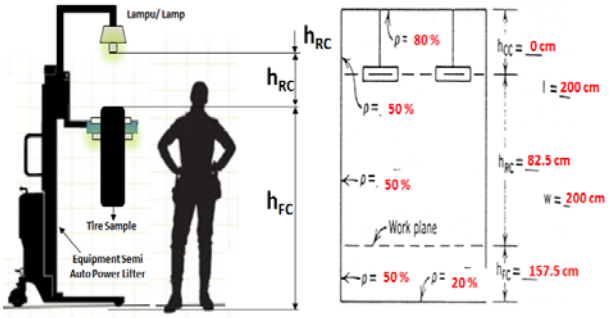

Figure 10: Determination of lamp height

With the plotting data can be achieved the height of the lamp 240 cm.

Where the h_{RC} as the height of the lamp against average height of *plane* 82.5 cm.

5.5. Calculation amount of the lamp that be used to comply with standard 500 – 1000 lux [15,17]

$$\text{Amount of the lamp (n)} = \frac{\text{Iluminance} \times \text{Area}}{\text{Lumens per Lamp} \times \text{Coeficient Utility (CU)} \times \text{Light Loss Factors Total (LLFtotal)}}$$

$$\text{Amount of the lamp (n)} = \frac{1000\ lux \times 0.2 \times 0.2}{1950\ (lm) \times 0.61\ X 0.79}$$

Amount of the lamp (n) = 4 Lamp.

5.6. Hardware dan Software GUI Program for recording Barcode

Hardware Design as below Figure 11. [19]

Figure 11: Design result of Hardware Scan Processing

Software design result with python [20,21,23, 24, 25,28,32] for the GUI (Graph User Interface) system display as below figure :

Figure 12: GUI Software program Display

GUI fill in result after scan the product :

Figure 13: GUI Software program Display after scan [23,30]

Data record in Mysql database can be accessed real time trough PhPmyAdmin as display below figure :

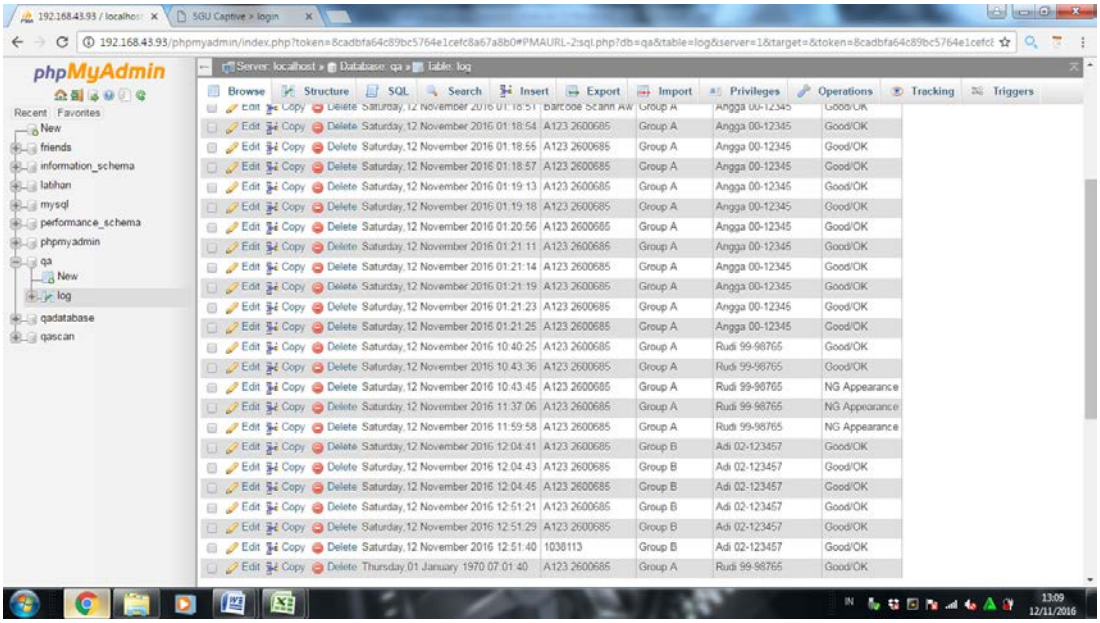

Figure 14: Real time data result scan barcode in MySQL and acessed with PhPMyAdmin

Data comparison of the process QA Re-Inspection without supporting device and manual data processing againts use Barcode scan process for and completed QA Re-Inspection process with supporting device as below tabel 5.

Tabel 5: Comparison data in process

Item to be compared in Re-inspection Process	**without supporting device not utilize scan barcode** Lux for lighting < 500 lux	**With supporting device, Lux lighting < 500 lux until < 800 lux , utilize scan barcode**
Total compliance to the target Check	50%	90%
Cycle Time process	8 minute / tires	3 minutes / tire
Entry Data processing	Manual use 1 resource to entry the Data	Automatically put in the system eliminate 1 resource for entry data
Lead time to have report	more than hours	every time the report available and real time
Traceability data	Since the report is manually Inspector can cheating which one tires that already inspected from Reinspection process difficult to known	Very easy for tracing data

6. Conclusion

From the results of design and analysis it can be concluded as follows:

a. The Quality Assurance Re-inspection process may utilize a locable movable process device wherein the apparatus can be used for rear diameter product inspection of "X" 20-22.5 inch products and according to the design results to meet the standard lighting process inspection required lamps with luminous flux lamp of 1950 (lm) of power 21 watts with minimum number of 4 lamps installed at max height. 240 cm measured from the floor surface with the average height of the workpiece from the ground level of 157.5 cm, able to meet the minimum lux standard to support the examination process that is at least 500 lux [15,17] so as to support work productivity.
b. Use of data records Barcode product inspection results using Graph User Interface (GUI) Barcode scan with interface microcontroller Raspberry Pi3 [31]based python programming language able to improve work productivity.
c. The use of resources can be reduced by eliminating personnel who are devoted to manually data entry and processing, work productivity increases.

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